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re "mechanism"
(from swm)

Eng A

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From ~~the~~ a biological standpoint, the mechanistic theory of life is more acceptable than the vitalistic one.

Can life be created in the laboratory? Can the scientist make synthetic organisms as he makes synthetic sugar or rubber? Of course, he cannot. We may, however, ask whether there is any possibility that science will ever reach that state. If the vitalistic conception of life — that the processes occurring in human organisms are guided and determined by some non-physical factor, known as the "vital principle" — is correct, science will never have such power. If, however, it is true that organisms are conscious or unconscious physical and chemical mechanisms, it is conceivable that the biologist may some day develop sufficient technique to construct an organism. It may, on the contrary, prove that even the simplest organisms are too complex and delicate to be produced synthetically. Biology will, nevertheless, be of the utmost importance, for the physiologist will discover the fundamental causes for our actions, and we shall eventually have to turn to the laboratory for our ethics. Such will be the case if organisms are physiochemical mechanisms, and are not controlled by a "vital force".

But this is still a question, and has not been solved altho it has been a matter of heated discussion

for several hundred years. From the early modern times we find the idea present that the processes occurring in living organisms are guided and determined by some non-physical force, acting unconsciously. Descartes was the first to put forward a thorough-going mechanistic theory of the working and development of the animal body. The body is represented, in so far as physiological knowledge extended at the time, as nothing but a piece of mechanism; and its development is also regarded as a simple mechanical process.

The chief motive power for the whole was supposed to be furnished by rhythmical expansions of the blood in the heart, owing to chemical explosions. If we trace the history of physiology onwards from the time of Descartes, we find constant conflict between mechanical and non-mechanical theories with all sorts of intermediate shades of opinion. The physical and chemical mechanisms assumed by Descartes and others who succeeded him were gradually proved to be non-existent ~~and~~ ^{or} non-effective, and new mechanisms took their place. With each new discovery of structure and function there came fresh modifications of mechanistic theories and fresh objections to them. The discovery of respiratory exchange in the latter part of the 18th century, the subsequent general application of chemical chemistry in physiological investigation, and the introduction of the compound microscope early last century, were potent factors in this development.

Up till the middle of last century the prevailing Util

It would be well to elaborate the lines a little + talk on blood.

physiological ~~opinions~~ opinions were on the whole more or less vitalistic. Among the younger physiologists about the middle of the century there arose, however, a very strong reaction against vitalism. Attack after attack was aimed at all the apparent strongholds of vitalism. Du Bois Raymond published observations pointing to an electrical theory of the propagation of nerve impulses; Liebig, tho himself a vitalist, put forward purely chemical theories of various physiological processes; Mayer pointed out the source of the energy of animal movement; and last of all came the publication of Darwin's "Origin of Species". The momentum of the intellectual movement has lasted to the present day, and the influence of this movement has spread in ever-widening circles. With every year of physiological advance, however, we seem to get further and further away from any prospect of a complete solution. It was only thro the prevailing ignorance of physiological facts that the scientists of the middle of last century imagined they were approaching a physico-chemical solution of elementary physiological problems. It has become evident that organisms are much more complex than had ever been imagined, and during the last decade, the realization of this fact has resulted in a slightly increased movement towards vitalism.

But this is not the only objection to the mechanistic theory. Those who favor vitalism say that the mechanistic theory is not sufficiently verified by experiment,

inasmuch as it not only cannot account for the existence of the marvellously complex characteristics possessed by physico-chemical structures, but also for the co-ordination of activity and growth of organisms, and for the fact that living organisms seem everywhere to present evidence of an autonomy of their own. These considerations are sufficient for most vitalists, but some go still further and declare that the mechanistic theory has been harmful, since the phenomena of life have repeatedly been represented as being much simpler than they were afterwards found to be.

The mechanists, on the other hand, proclaim the usefulness of their theory as its greatest asset. They go so far as to say that if at any time a vitalistic theory should be proposed that warrants being more fruitful in research than the mechanistic theory, they would immediately abandon the latter. They say, also, that the mechanistic theory has been sustained by experiment. They meet the specific objections of the vitalists and proceed to describe multitudes of investigations to uphold their theory.

Thus the contest has ranged round two points, and the path to the solution of our question runs through them. Let us, then, attempt to decide whether the mechanistic hypothesis is sufficiently sustained by experiment, and whether it is of greater pragmatic value. The first question is of greater importance to vitalists than to mechanists, for while the usefulness of the mechanistic theory is uppermost in the minds of its supporters it is of secondary importance to most vitalists.

Mechanists, however, are always eager to cross over and meet vitalists on their own ground, and we shall follow them there first, where they will attempt to show that scientific investigation supports their theory.

The researches of countless investigators have established with practical unanimity certain very fundamental facts with regard to living organisms. One of these is that the matter of which the bodies of organisms are found by analysis to be composed consists of the same chemical elements as are found outside the body, and that no new matter is formed in the body, or disappears from it. All the matter which is found in the body, or which passes from it can be accounted for by what is taken up from the environment. Of the particular chemical substances, moreover, which have been found in the body a large and increasing ~~large~~ number can be formed artificially outside of it, and there is no reason to suppose that any ultimate difficulty will be experienced in artificially forming any of the chemical substances which have been discovered, or are likely to be discovered, within the body.

Another fundamental fact is that the whole of ~~of~~ the energy which is liberated in the body, whether as heat, mechanical work, or in other forms, can be traced to sources outside the body.

The two great ^{physical} laws of conservation of matter and energy can thus be extended with apparently rigorous accuracy, to all living organisms, including human beings. From this it may be inferred that, however

complex may be the changes involved in organic activity, they are nothing but changes in a material system. As yet we are far from able to trace this system and its changes completely, but the main outlines are clear, and the gradual filling in of details can only be a matter of time, though we shall probably never succeed in filling in all the details.

The mechanistic theory may be supported by another set of considerations, which appeal very strongly to many scientific investigators. In all biological investigations, we are investigating either structure or activity; and when we come to details we find that the structure is physical and chemical structure and the activity physical and chemical activity. Hence biology can be nothing but the physics and chemistry of organisms.

This point may be illustrated in almost infinite detail. Let us suppose that we are engaged in anatomical investigation. With the scalpel, microtome, microscope, fixing and staining reagents and other physical or chemical apparatus we separate (out) or render distinguishable the details of structure. But these details are only details of form, size, color, physical or chemical characters, and spatial relations to other parts. The facts we ascertain are physical and chemical facts, and the methods we use are physical and chemical methods.

If, on the other hand, we are making a physiological investigation, the same is no less true. If we are investigating secretion, we are measuring the mass or volume of the substances secreted, or their chemical composition, or perhaps

From Darwin's...

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their osmotic pressure, or concentrations of ions in them. If we are investigating muscular contraction, we are measuring the rate and extent of the contraction, or the accompanying heat produced. The phenomenon which we observe is always some physical or chemical change. The methods we use are physical and chemical methods, and the resulting facts are consequently physical and chemical facts.

From the very nature of its methods and facts, therefore, biology can be nothing but applied physics and chemistry. When we come to matters of detail it appears that biology does nothing and can do nothing, but asks physical and chemical questions, and obtains physical and chemical answers, in so far as the answers are more than partial answers. We may not be able to give a complete statement in physical and chemical terms, but it remains true, nevertheless, that the facts we are ascertaining are ^{apparently} nothing but physical and chemical facts, however imperfectly defined. Beyond these facts all is more or less empty speculation.

For further support the mechanistic theory can appeal to the actual history of biology, and particularly of physiology. The history of physiology displays uninterrupted progress in the successful application of physical and chemical facts to physiological problems. To take only a few examples, the principles of mechanics were applied by Boerhaave to elucidate the action of the muscles on the limbs. Kepler applied the principles of optics to the action of the eye in vision. Harvey established and analyzed the facts relating to the circulation of the blood by the application of purely physical observation and reasoning.

As a result of the great advance in chemistry at the end of the eighteenth century the fundamental facts with regard to respiration and its relation to nutrition and animal heat were discovered; and since then the application of chemical methods to physiological problems has continued with unbroken success. It is doubtless the case that the application of chemistry to physiology has also shown us that the chemistry of life is far more complex than was formerly suspected. This, however, cannot legitimately be used as an argument against the mechanistic theory: for the progress which has been made by applying chemical methods is solid progress, to which there has been no set-back, tho' the goal has turned out to be farther away than appeared to be the case about the middle of last century, at the time of the general movement of physiologists towards the mechanistic theory.

We have still to account for the existence of physico-chemical structures possessing the marvellous characteristics of living organisms - so different from anything found in the inorganic world. Here the genius of Charles Darwin has provided an explanation in harmony with the mechanistic theory. No type of organism can survive in which the physiological mechanisms are not so constituted ~~that~~ and so co-ordinated that the organism is capable of completing a life-cycle culminating in the transmission of a similar structure to its descendants. Those organisms and their descendants which have varied in structure in a ~~way~~ direction which gives them a smaller

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probability of surviving will become extolled in the fierce struggle for existence which prevails everywhere among living organisms. On the other hand, those which have varied in such a direction as to give them a greater probability of surviving will increase and multiply, displacing the inferior types. Hence by the blind operation of natural selection through countless ages higher and higher types of organism will be produced.

Perhaps the most striking with regard to physiological phenomena is the evidence they present of actively co-ordinated in such a manner as to conduce towards the survival of either the individual or the species. Co-ordination of a similar striking kind is not found anywhere outside of the organic world; and the mere existence of this co-ordination has been taken as strong evidence for the presence in living organisms of some co-ordinating influence apart from blind physical and chemical forces.

The reply to this conclusion is that many of the mechanisms by which co-ordination is brought about have already been discovered, and that every year more is being discovered about them. Descartes, in his writings about the nervous system, was the first to point the way in this line of discovery. He suggested nervous mechanisms by means of which afferent stimuli and muscular responses are co-ordinated; and since his time the theory—that the nervous system is at bottom nothing more than a complex system of reflex mechanisms has been experimentally verified in many directions, and has now

become a generally accepted physiological doctrine.

It is ^{not} however, ~~only~~ in connection with the nervous system only that co-ordinating mechanisms have been discovered. It has been known for long that chemical substances produced by the activity of one organ are conveyed by the blood to other organs, in which they excite activity of such a ~~sort~~ nature as to maintain the normal structure, composition, and functional activity of the body as a whole. It is not merely in the case of functional activity that chemical stimuli play an important part; for evidence is now steadily accumulating that co-ordination of growth and maintenance in different parts of the body is dependent on the action of substances conveyed from one part to another by the blood and lymph circulation, or by simple diffusion from one contiguous part to another.

There thus appears to be no difficulty in regarding a living organism as a complex system of physico-chemical mechanisms, each of which is controlled by the rest in such a way that the normal structure and activity of the organism is, under ordinary conditions, maintained. The existence of these mechanisms can be verified by exact experiment. Hence the co-ordination of growth and activity, as found in living organisms, presents, in itself, no real difficulties for the mechanistic theory.

We now come to one of the strongholds of vitalism. Does not the possession of a "will" mark the difference between inorganic and organic matter? Can mechanisms possess the "free-will" apparently shown

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by many organisms? In recent years the biologist has attacked this problem, and, altho he has not yet completely solved it, much has already been discovered. Jacques Loeb has investigated the actions of many of the lower animals and has indisputably shown that their movements are due to tropisms — forced turnings or bendings to or away from a stimulus. In "The Organism as a Whole" Loeb gives many interesting illustrations of these forced movements. He has succeeded in solving the problem of the amoeba by tropisms. The movement after food by this creature has always been a source of mystery to biologists. The amoeba cannot see, smell, hear, or feel the food, and yet it goes directly towards it. Can the amoeba have superhuman powers? Many scientists concluded that it has, and great was the praise showered on the humble amoeba. Loeb discovered that the food diffuses in the water, so that particles coming to the side of the amoeba cause a chemical reaction to take place. These reactions cause the amoeba to move towards the food, where he finally arrives. Such a movement is termed a chemotropism. The action of certain caterpillars afford another illustration of Loeb's investigations. These particular caterpillars are born early in spring at the feet of trees. As soon as they are able to, they climb up to the uppermost branches where they patiently wait until the buds appear, and then eat them. Is not this a remarkable creature? Surely, human babies are inferior. But let us take some of the caterpillars into the laboratory. There we put them in a test tube and place

some food next to them. On their other side is a source of light. The caterpillars starved to death. If, now, the light is put on the same side of the food, next to the food, the caterpillars eat the food. But if the light is drawn away a little the caterpillars move towards it passing the food and starve to death. They are slaves to light. It has, moreover, been found that the action of the caterpillars conforms to the Bunsen-Roscoe law of physics. Loeb does not conclude from these experiments that human actions are due to tropisms, but simply raises the question. He shows that ~~the~~ tropisms are the bases of the instincts of many lower animals, and he asks where we are to draw the line between the lower and higher animals. We thus see that the stronghold of "free-will" has already been undermined.

We have seen that the changes involved in organic activity are changes in a material system; that the history of biology displays an uninterrupted progress in the application of physico-chemical methods to biological questions; that the nervous system and chemical stimuli furnish mechanisms for the co-ordination of functional activity and growth in organisms; that Darwin's theory of evolution affords an explanation of our mechanical principles for the existence of marvellously complex organisms; and, lastly, that Loeb's work on trochisms has provided a physicochemical explanation of "free-will".

Let us now turn to the question: Is the mechanistic theory of greater pragmatic value? This is regarded by the mechanists as being more important than the previous question,

while the opposite view is held by the vitalists.

We can, perhaps, decide whether the question of usefulness is important or not after we have seen just how the theories compare in this way.

Mechanists claim that the action of the vital principle, ~~if it exists~~, is unintelligible, for if it exists, it is determined in its action by physical and chemical conditions. The apparent autonomous selective action of the organism turns out to be causally dependent in every detail on physical and chemical conditions. It is, therefore, only from an outside and superficial view that there appears to be something in a living organism which acts, within limits, independently of the physical and chemical conditions of environment. As a positive working hypothesis it is, therefore, useless; at the best it only serves to express our ignorance of the exact means by which the parts of a living organism are caused to react in a certain manner to a given physical or chemical change.

Furthermore, in order to "guide" effectually the excessively complex physical and chemical processes occurring in living material, and at many different parts of a complex organism the vital principle would apparently require to possess a superhuman knowledge of these processes. Yet the vital principle is assumed to act unconsciously. The very nature of the vitalistic assumption is thus totally ~~un~~ unintelligible. From this point of view also the hypothesis is useless: for even if we cannot completely understand a living organism by the aid of physics and chemistry, we do not improve matters by postulating an agency which is itself entirely unintelligible.

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The theory of vitalism is not only useless, but is actually harmful, for it has again and again discouraged research. Thus, when Pasteur was investigating the action of yeast he found its action unexpectedly complex. It seemed to him that it acted contrary to established scientific laws. Being a vitalist, Pasteur announced that some "vital force" was operating in the yeast and that man could not, therefore, hope to solve the problem any further, and thus the matter rested. Buchner, however, scorned the idea of a "vital force" in yeast, subjected a mixture of sand and yeast to enormous pressure and discovered that the mysterious action was due to new substances, which he called enzymes. By squeezing the "vital force" out, so to speak, he made a very far-reaching discovery. The history of science is filled with examples of discoveries made possible by the substitution of the mechanistic theory for the vitalistic one. Beginning with Newton, who dispelled the idea of a vital force acting in the physical world, thru Lyell and Darwin down to such scientists as Morgan and Loeb, progress has ~~only~~ only been possible by the rejection of a "vital force" and the assumption of physical and chemical mechanisms. The vitalistic theory has been not only useless, but actually harmful. Is biology to retain a hypothesis that has been the bane of all science?

We have crossed over to the ground of ~~the~~ vitalism and have found that, altho experiment does not altogether confirm the mechanistic theory, it upholds it

sufficiently. We then came back to the chosen ground of the mechanists, and saw that the mechanistic theory is of much greater pragmatic value than the vitalistic one. Thus it evidently affords biologists a perfectly clear working hypothesis that the peculiar phenomena of life are due to the play of the physical and chemical environment on ~~the~~ intra-protoplasmic mechanisms which have been evolved thru the influence of natural selection acting for ages. If this ~~is~~ theory is correct, the aim of biology is to unravel the mechanism.

An excellent argument.

Faults:-

you use (necessarily perhaps) big words. Every time you can substitute a small or commoner word for a longer one you gain in style. Compare the introduction of Huxley's "Lectures on Evolution". He is a scientist yet his style is simple.

You ~~use~~ use bad or colloquial expressions once in a while e.g. "separate out"

you could use more evidence to advantage and more concrete language although you are not bad in this respect.